A comparison of the nutrition utilization abilities of some small mammals and song-birds

By

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Abstract. Our study describes the experiments on two species of small mammals (rodents) and two species of birds. These are listed in the itroductory passage. For the duration of the experiment, the animals were fed only millet seed. Birds consumed relatively (expressed as a function of their body weights) twice as much food as small mammals. However, the latter utilized their food better than birds. For each unit of food, mammals produced only half as much faecal and urinal matter as birds. At the same time, the two mammal species were similar to each other, and the two bird species were similar to each other. From a production biological viewpoint, mammals and birds - perhaps as a result of the phylogenetic development - represent two clearly delimitable types.

The process of thermoregulation requires a lot of energy, which means that homoiotherm animals (mammals and birds) oxidize significantly more food than they need for the maintenance of their metabolism (Gere, 1982, 1993). Based on this fact, Hemmingsen (1960) grouped mammals and birds into one category from the point of view of production biology. At the same time, it seems that there are significant differences between birds and mammals. Studies that deal with environmentally or agriculturally important species of these two groups of animals call attention to the fact that mammals consume relatively less food in a given time period than birds. A few other reports support this observation as well. According to Turček (1956), the consumption intensity (the dry weight of the daily amount of food consumed as a percentage of live body weight) of the Yellow-necked mouse (*Apodemus flavicollis*) fed on tree-seeds is 7.6 % at temperatures between 18 and 26 °C. The same figure for the Tree sparrow (*Passer montanus*), which also feeds on seeds and has a body weight slightly less than the mouse, was 2.3 times greater (Gere, 1981). A similar difference can be observed by comparing the Red-backed vole (*Clethrionomys rutilus*) (Gere, 12973) to the Zebra finch (*Taeniopygia guttata*) (Grodzinski, 1971). Shrews, however, according to the above author, constitute an exception because of their high metabolic rate.

Thus, no overall generalizations can be made concerning the metabolic rate of animals, and it seems that only limited generalizations can be made

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about birds. Lasiewsky and Dawson (1967), as well as Kendeigh (1970) differentiate between the productivity of song-birds and nonsong-birds. Our previous studies support the likelihood of this difference (Gere, 1973, 1974, 1980-81, 1981; Gere & Andrikovics, 1986, 1994).

The above points prove that several more examinations are necessary in order to obtain an overall picture of the production biological performances of birds and mammals, as well as the differences between these two groups of animals. Towards this end, we have made comparative studies on two rodent species and two song-bird species. The species involved were the following:

Dwarf campbells Russian hamster (*Phodopus campbelli* Thomas) (Fam. Cricetidae)
Chinese hamster (*Cricetulus barabensis* Pallas) (Fam. Cricetidae)
Zebra finch (*Taeniopygia guttata* Vieill.) (Fam. Estrildidae)
Bengalese finch (*Lunchura striata* (L.) forma *domestica*) (Fam. Estrildidae)

For the purposes of better comparison, we chose only seed-eating species that can be fed with the same food for the duration of the experiment. Furthermore, we chose species whose individuals have been kept in captivity for several generations, thus the experimental situation is less stressful for them. At the same time, we believe that partial domestication has not influenced the nature of their metabolism because their selection for breeding has not been done on this basis. Let us note that we have previously done similar experiments on the two bird species involved (Gere, 1973, 1974). In order to provide better comparison and to maintain the same circumstances, we have repeated these experiments.

Methods

The experimental small mammals were housed individually in 17 × 15 cm plastic boxes. These boxes were covered with wire-mesh having 4 mm^2 holes. The birds were housed - also individually - in 31 x 18 cm bird cages, equipped with 2 sitting rods.

The animals were fed 3.0 g of air-dried millet seed daily. Every day, the leftover food was collected and measured in order to determine the amount of food consumed. Daily production of faecal and urinal matter (FU matter) was also collected and measured in air-dried state. Water was available to the animals as needed.

The natural habitat of the small mammals is the continental steppe (Wilson & Reeder, 1993). The Zebra finch is native in the dry areas of inner Australia (Immelmann, 1871). Although the Bengalese finch does not inhabit dry areas, it feeds mainly on monocotyledonous plants' seeds (Robiller, 1978). Thus the food of ripe (dry) millet seeds was not alien to any of the involved species.

Table 1. Average live weight of animals on the first day of the experiment

Species	Dwarf campbells Russian hamster	Chinese hamster	Zebra finch	Bengalese finch
Gramme	23.91	20.87	11.91	12.10

Table 2. Data for food consumption by the animals

Species	Dwarf campbells Russian hamster	Chinese hamster	Zebra finch	Bengalese finch
Day	Extreme values and averages of daily consumptions (g)			
1.	2.45-2.90 2.62	1.44-2.50 2.15	2.07-2.72 2.41	2.39-2.59 2.49
2.	2.50-2.90 2.70	2.04-2.54 2.39	2.41-2.60 2.49	2.08-2.57 2.40
3.	1.00-2.90 2.42	2.24-2.49 2.42	2.33-2.59 2.48	2.43-2.55 2.48
4.	1.00-2.60 1.97	0.50-2.50 2.23	2.40-2.77 2.50	2.39-2.54 2.49
5.	1.70-2.90 2.54	2.22-2.55 2.44	2.27-2.76 2.49	2.42-2.64 2.48
5-day averages	2.45	2.33	2.47	2.47

We used 10 developed (adult) individuals of each of the four species in our experiment. The experiment lasted for 10 days. The first five days were devoted to getting the animals accustomed to their new homes and the monotonous (but not unnatural) food necessary for the experiment. Measurements were taken during the next five days only.

Temperature was maintained between 20 and 22 °C. Light was provided for 11 hours daily.

Results and evaluation

Table 1 presents the average live body weight of animals on the first day of the experiment. As can be observed, the body mass of the mammals was approximately double that of the birds. Since the individuals involved in the experiment were not in their growing stages, we do not consider changes in their body weights. Production (P) can be considered zero.

Table 2 presents the extreme values and the averages of daily food intake. The distribution of these data is quite small, indicating that the animals' metabolism took place under balanced circumstances.

Table 3. Data for faecal and urinal matter (FU) produced by the animals

Species	Dwarf campbells Russian hamster	Chinese hamster	Zebra finch	Bengalese finch
Day	Air-dried mass (extreme values and averages) of daily FU matter (g)			
1.	0.12-0.23 0.18	0.02-0.28 0.12	0.24-0.38 0.32	0.22-0.51 0.35
2.	0.17-0.26 0.21	0.05-0.27 0.14	0.27-0.37 0.32	0.27-0.38 0.31
3.	0.14-0.23 0.19	0.12-0.25 0.16	0.24-0.57 0.37	0.25-0.44 0.33
4.	0.10-0.23 0.15	0.09-0.22 0.15	0.30-0.60 0.39	0.24-0.40 0.31
5.	0.12-0.22 0.16	0.09-0.36 0.18	0.24-0.46 0.34	0.22-0.38 0.30
5-day averages	0.18	0.15	0.35	0.32

It is striking to notice that the smaller birds consumed about as much food as the larger mammals. The results thus confirm what could be expected based on the above-mentioned facts; namely, that seed-eating birds need relatively more food than small rodents. The difference in the intensity of food consumption between the two groups of animals is great enough to be significant even if we account for the "law of body-surface." This law states that the amount of food consumed by animals is primarily determined by the surface area of their bodies, not by body weight. Thus, smaller animals eat relatively more than larger ones.

Several other important observations can be made based on the data presented in Tables 3 and 4. Table 3 gives daily productions of faecal and urinal matter (FU matter) for each of the 4 species' 10 individuals. Table 4 indicates the average ratios of FU matters to consumption (C). The "production" of the two mammal species as well as of the two bird species are very similar in this area; however, there are major differences between the mammals and the birds. Mammals utilize the food they consume to a much greater extent than birds. The ratio of FU matter to food consumed was twice as much in the case of birds as in the case of mammals. Therefore, birds meet their matter and energy needs by consuming larger amounts of less utilized food than mammals, which consume smaller amounts of more effectively utilized food. In this respect, the animals represent two clearly delimitable types, which can perhaps be explained by phylogenetic development. Our prior studies (Gere, 1982) also indicate that the food utilization abilities of animals, besides the occasional adaptation and the resulting convergences, is a function of phylogenetic development as well.

Table 4. The ratio of faecal and urinal (FU) matter production to food consumption (C) during the experiment

Species	Dwarf campbells Russian hamster	Chinese hamster	Zebra finch	Bengalese finch
$\frac{FU \times 100}{C}$				
5-day averages	0.18	0.15	0.35	0.32

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